

WHAT IS CLAIMED IS:

- 1 **SUB**
2 **AI** 1. A method for forming a dielectric layer on a silicon substrate
3 which includes a silicon trench formed between upper portions and having a trench
4 bottom and a trench wall, said substrate disposed in a substrate processing chamber,
5 said method using a precursor which provides deposition rate dependence of said
6 dielectric layer on differently constituted surfaces at different levels on the substrate,
7 said differently constituted surfaces at different levels comprising said trench bottom
8 and a material on said upper portions, the method comprising the steps of:
9 introducing said precursor, preferably TEOS, into said substrate
10 processing chamber;
11 flowing ozone into said substrate processing chamber to react with
12 said precursor to deposit a dielectric layer over said substrate; and
13 adjusting an ozone/precursor ratio between said ozone and said
14 precursor to regulate deposition rates of said dielectric layer on said differently
15 constituted surfaces until said dielectric layer develops a substantially planar
dielectric surface.
- 1 2. The method of claim 1 further comprising, prior to said
2 introducing, flowing, and adjusting steps, the step of cleaning said trench.
- 1 3. The method of claim 2 wherein said cleaning step includes
2 exposing said trench to a wet etchant.
- 1 4. The method of claim 1 wherein said material on said upper
2 portions includes a CVD anti-reflective coating on said silicon substrate.
- 1 5. The method of claim 1 wherein said trench is formed by
2 applying a CVD anti-reflective coating on and contacting said silicon substrate;
3 forming a photoresist on said CVD anti-reflective coating; exposing a portion of
4 said photoresist to a light to define a location where said trench is to be formed;
5 removing said photoresist at said location; and etching, at said location, through
6 said CVD anti-reflective coating and through a depth of said substrate to form said
7 trench at said location.

1 6. The method of claim 1 further comprising the steps of flowing
2 an oxygen-containing gas into said substrate processing chamber and heating said
3 substrate to substantially simultaneously densify said dielectric layer and to form a
4 thermal oxide at said trench bottom and trench wall.

1 7. The method of claim 1 wherein said adjusting step includes
2 generating faster deposition rates on lower surfaces than on higher surfaces of said
3 substrate.

1 8. The method of claim 1 further comprising the step of
2 generating a pressure of about 200-700 Torr and a temperature of about 300-500°C
3 in said substrate processing chamber.

1 9. The method of claim 1 wherein said adjusting step includes
2 adjusting said ozone/precursor ratio to about 10:1 to 20:1, preferably about 13:1.

1 10. The method of claim 9 further comprising the step of
2 controlling a pressure in said substrate processing chamber based on an
3 ozone/precursor ratio selected during said adjusting step.

1 11. A substrate processing system comprising:
2 a housing defining a process chamber;
3 a substrate holder, located within said process chamber, for holding a
4 silicon substrate which includes a silicon trench formed between upper portions and
5 having a trench bottom and a trench wall;
6 a gas delivery system for introducing process gases into said process
7 chamber;
8 a controller for controlling said gas delivery system; and
9 a memory coupled to said controller comprising a computer-readable
10 medium having a computer-readable program embodied therein for directing
11 operation of said controller, said computer-readable program including a set of
12 instructions to control said gas delivery system to introduce a process gas including

13 ozone and a precursor into said process chamber to form a dielectric layer on said
14 silicon substrate, said precursor providing deposition rate dependence of said
15 dielectric layer on differently constituted surfaces at different levels comprising said
16 trench bottom and a material on said upper portions of said silicon substrate, and to
17 adjust an ozone/precursor ratio between said ozone and said precursor until said
18 dielectric layer develops a substantially planar dielectric surface.

1 12. A method for processing a substrate including a trench having
2 a trench surface and a trench fill material disposed thereon, said substrate disposed
3 in a substrate processing chamber, the method comprising the steps of:
4 providing an oxygen-containing gas in said substrate processing
5 chamber; and
6 heating said substrate to substantially simultaneously densify said
7 trench fill material and to form a thermal oxide at said trench surface.

1 13. The method of claim 12 wherein said oxygen-containing gas is
2 selected from the group consisting of molecular oxygen gas and steam.

1 14. The method of claim 12 wherein said heating step includes
2 increasing a temperature of said substrate to at least about 800°C.

1 15. A substrate processing system comprising:
2 a housing defining a process chamber;
3 a substrate holder, located within said process chamber, for holding a
4 substrate including a trench having a trench surface and a trench fill material
5 disposed thereon;
6 a gas delivery system for introducing process gases into said process
7 chamber;
8 a heater for heating said substrate;
9 a controller for controlling said gas delivery system and said heater;
10 and
11 a memory coupled to said controller comprising a computer-readable
12 medium having a computer-readable program embodied therein for directing

13 operation of said controller, said computer-readable program including a set of
14 instructions to control said gas delivery system to introduce an oxygen-containing
15 gas into said process chamber and to control said heater to heat said substrate to
16 substantially simultaneously densify said dielectric layer and form a thermal oxide at
17 said trench surface.

1 *SUB 2* 16. A method for forming a trench isolation structure on a
2 substrate, the method comprising the steps of:
3 applying a CVD anti-reflective coating on and contacting said
4 substrate;
5 forming a photoresist on said CVD anti-reflective coating;
6 exposing a portion of said photoresist to a light to define a location
7 where a trench is to be formed;
8 removing said photoresist at said location; and
9 etching, at said location, through said CVD anti-reflective coating and
10 through a depth of said substrate to form said trench at said location.

1 17. The method of claim 16 wherein said CVD anti-reflective
2 coating is applied with a thickness of about 1000-2000 Å.

1 18. The method of claim 16 further comprising, following said
2 etching step, the steps of:
3 removing a remainder of said photoresist; and
4 filling said trench on said substrate with a trench fill material,
5 preferably an oxide.

1 19. The method of claim 18 wherein said oxide comprises an
2 oxide film produced by reacting a precursor, preferably TEOS, and ozone.

1 20. The method of claim 19 wherein said oxide film has a ratio of
2 said ozone to said precursor of about 10:1 to 20:1, preferably about 13:1.

1 21. The method of claim 19 further comprising the steps of:

2 subjecting said substrate to an oxygen-containing gas; and
3 heating said substrate to substantially simultaneously densify said
4 trench fill material and to form a thermal oxide at an interface between said trench
5 fill material and a surface of said trench.

1 22. The method of claim 18 further comprising the steps of:
2 subjecting said substrate to an oxygen-containing gas; and
3 heating said substrate to substantially simultaneously densify said
4 trench fill material and to form a thermal oxide at an interface between said trench
5 fill material and a surface of said trench.

1 23. The method of claim 18 wherein said trench filling step
2 includes depositing a layer of said trench fill material in said trench and said CVD
3 anti-reflective coating; and selectively removing said trench fill material over said
4 CVD anti-reflective coating.

1 24. The method of claim 23 wherein said selective removing step
2 is a chemical mechanical polishing step and wherein said CVD anti-reflective
3 coating acts as an etch stop for said chemical mechanical polishing step.

1 25. The method of claim 16 wherein said CVD anti-reflective
2 coating is formed by a plasma-enhanced chemical vapor deposition of a dielectric
3 material.

1 26. The method of claim 25 wherein said dielectric material is
2 selected from the group consisting of silicon nitride and silicon oxynitride.

1 27. The method of claim 16 wherein said CVD anti-reflective
2 coating comprises silicon carbide.